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Sewage Disposal for Rural Dwellings

Issued Jointly by

Department of Health
Division of Sanitary Engineering
State of Ohio

and

The Agricultural Extension Service
Department of Agricultural Engineering
College of Agriculture, the Ohio State University

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Sewage Disposal for Rural Dwellings

THIS bulletin deals with the design of sewers and sewage treatment plants for rural residences having less than ten inhabitants. In presenting this information, the object has been to discuss the general features involved in the disposal of sewage, and to suggest the most satisfactory methods which are adaptable under the conditions ordinarily encountered. Expert advice should be obtained in specific instances where topographical conditions, proximity of water supplies, or other features may render the solution of the problem particularly difficult.

Attention is particularly called to the fact that the sewage treatment plant designs outlined in this bulletin are not recommended for dwellings in built-up communities. In such instances the proper recourse for sewage disposal is a system of sanitary sewers to serve the community, said sewers to collect the sewage and remove it to a suitable point for disposal.

The development of water supplies for homes is not touched upon in this article except as the location of the water supply affects the design and layout of the sewers and sewage treatment devices. The primary requisite of residential sanitation is the assurance of a safe and potable water supply. The State Department of Health can furnish detailed information and drawings on the development of wells and springs and also on the installation of the pumping equipment.

PLUMBING

The plumbing system for the country home is not unlike that for a city dwelling. In the country, however, the system cannot be connected to a public sewer and the water supply cannot be obtained from a public system of supply. Nevertheless, with proper sewage disposal and a water supply under pressure such as the common pneumatic system, a rural dwelling can be provided with all the conveniences of the city dwelling respecting the disposal of domestic wastes.

It is very important that certain rules be followed in the installation of the plumbing in the rural residences, to assure proper operation of not only the plumbing and fixtures but also the sewers and sewage treatment devices.

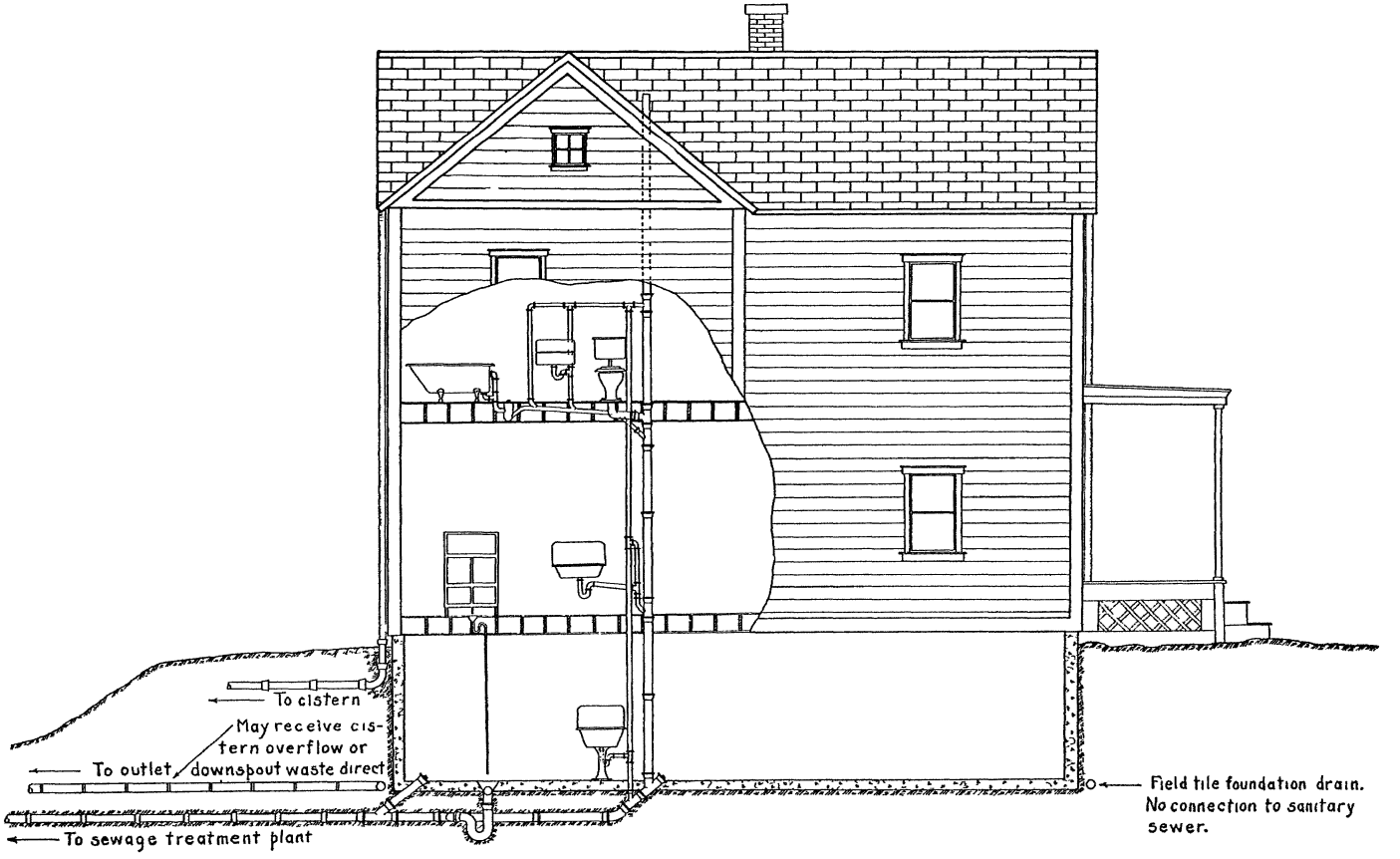


FIG 1.—OUTLINE OF PLUMBING AND DRAINAGE SYSTEM FOR A RESIDENCE

PLUMBING AND DRAINAGE FOR DWELLINGS (FIG. 1)

In presenting this design, it is not the object to encourage attempts on the part of persons untrained in plumbing practice to make the installation, but it is intended to demonstrate to plumbers, as well as laymen, the essential principles to be observed in such construction. The property owner must recognize the necessity of employing an experienced plumber, to secure the best results from the expenditure made for the plumbing system.

Figure 1 shows a drainage system serving a bath tub, toilet, and lavatory on the second floor, kitchen sink and refrigerator on the first floor, and a laundry tray and floor drain in the basement. Note that these fixtures are connected to the sewer leading to the sewage treatment plant, and that the downspouts and foundation drains are connected to separate sewers. Under no conditions should the downspouts or foundation drains be connected to the sanitary sewer. If this connection is permitted, the sewage treatment plant will be greatly overloaded and possibly the entire system put out of operation in a short time. These clear waters can be discharged into any drainage course about the home .

It is essential that a system of ventilation be provided for the plumbing system to allow for free circulation of air, removal of the foul odors, and to prevent breaking the seal of the fixture traps. Figure 1 shows an extra heavy cast iron soil pipe extending from the sanitary sewer in the basement up through the building, paralleling the stack and connecting with the stack above the uppermost fixture. This provides ventilation for not only the fixtures but the sewer and sewage treatment devices. The stack is the main vertical drain for the various fixtures, and extends 2 feet above the roof.

Cleanouts should be installed on the sanitary sewer immediately inside the cellar wall and at the base of the vertical pipe stack, to permit access to the sewer in the event of a stoppage. The cellar floor drain should be equipped with a back pressure valve to prevent the back flow of sewage into the basement should the sewer become clogged. Note that there is no trap in the sewer leading away from the building.

All the details shown in Figure 1 are typical of the requirements of the State Plumbing Code. A satisfactory and efficient plumbing system will be had if the construction, installation, and test are made in accordance with the provisions of the Ohio Code.

SEWAGE TREATMENT

Untreated or raw sewage may not be discharged to any stream, lake, or pond in the state of Ohio. In certain instances where the residence is located adjacent to a stream which contains a large flow of water throughout the year, it may be feasible to omit the secondary sewage treatment devices shown on the following diagrams, described below, and discharge the overflow from the settling tank directly into the stream. However, many variable conditions such as stream flow, velocity, character of stream, uses of stream, etc., must be taken into account before this method of sewage disposal is adopted. Attention is called to the fact that many local Boards of Health have adopted regulations governing the installation of private sewage disposal devices; accordingly your local health commissioner should always be consulted before proceeding with an installation of this kind.

Many people are of the opinion that a settling tank or "septic" tank transforms the sewage into a clear sparkling water fit to drink. The function of the tank is to remove the solid matter from the sewage, and actual tests have shown that the overflow or effluent from a "septic" tank is even worse in bacterial quality than the sewage which entered. The overflow from any type of "septic" or settling tank cannot be discharged to a stream of intermittent flow or to a storm drain without causing a nuisance condition.

The type of sewage treatment plant to be installed for a residence is determined by (a) the nature of the subsoil—whether of clay, sand, or gravel; (b) the area available for a treatment plant; (c) the volume of flow in the receiving stream; and (d) the uses of the receiving stream below the sewer outlet.

Grease Traps

Considerable trouble is sometimes experienced in the operation of small sewage treatment plants by the presence of grease coming from the kitchen. The grease forms a scum on the surface of the settling tank and will, if permitted to accumulate, flow into the secondary treatment device, clogging the drains and filtering material. The grease cannot be removed from the settling tank very easily, so it is advisable to prevent its entrance into the tank by intercepting it in a grease trap installed on the sewer line from the kitchen. A grease trap is merely a small tank which retards the flow of the waste while the grease rises to the top. There are a number of patented types of grease traps that may be installed, or one may easily be constructed of concrete.

A grease trap for the home should be approximately 18 inches long, 15 inches wide, and 24 inches in depth below the inlet sewer. The outlet should be through a tee fixture which will draw off the liquid at least 18 inches below the surface. A removable cover should be provided for the trap to permit access occasionally to skim off the grease.

Settling Tank and Leaching Well (Fig. 2)

This type of sewage treatment plant is adaptable only for places where the natural subsoil in which the leaching device is installed, is of a sandy or gravelly nature free from ground water. The ground must be sufficiently porous to permit the sewage to drain from the leaching well, and the ground water level must be sufficiently below the device so as not to interfere with the leaching action.

The layout and profile at the top of Figure 2 show the sewer leading from the dwelling, and the location of the settling tank and leaching well with respect to the water supply of the home. In order to give reasonable assurance that the sewage will not drain into a water supply, the sanitary sewer must be of extra heavy cast iron soil pipe with leaded joints where within 300 feet of the supply, and the leaching well must be located beyond this distance.

The settling tank should be located as far as possible from the dwelling and from all water supplies; it is advisable to construct the settling tank at least 30 feet removed from the leaching well. The sewer line should not be less than 4 inches in diameter and should be sloped at least ⅛ inch per foot. If the grade of the sewer line is changed, a manhole or cleanout should be installed at the break in grade. Likewise, a manhole or cleanout should be installed at each change in direction of a sewer line.

The settling tank shown in Figure 2 is of concrete and has a capacity of 675 gallons. It is designed to detain the sewage for a period of at least eight hours, thus allowing the heavier solids to drop to the bottom. Since over 50 per cent of these solids remain after digestion is complete, it is necessary that the tank have an effective depth of at least 5 feet to allow adequate space for the accumulation of these solids.

The inlet to the tank should be at least 3 inches higher than the outlet, to prevent the sewage from backing up in the sewer from the dwelling. The flow coming into the tank should be carried below the surface of the liquid at least 24 inches either by a baffle board such as that shown on Figure 2, or by a cast iron cross fix-

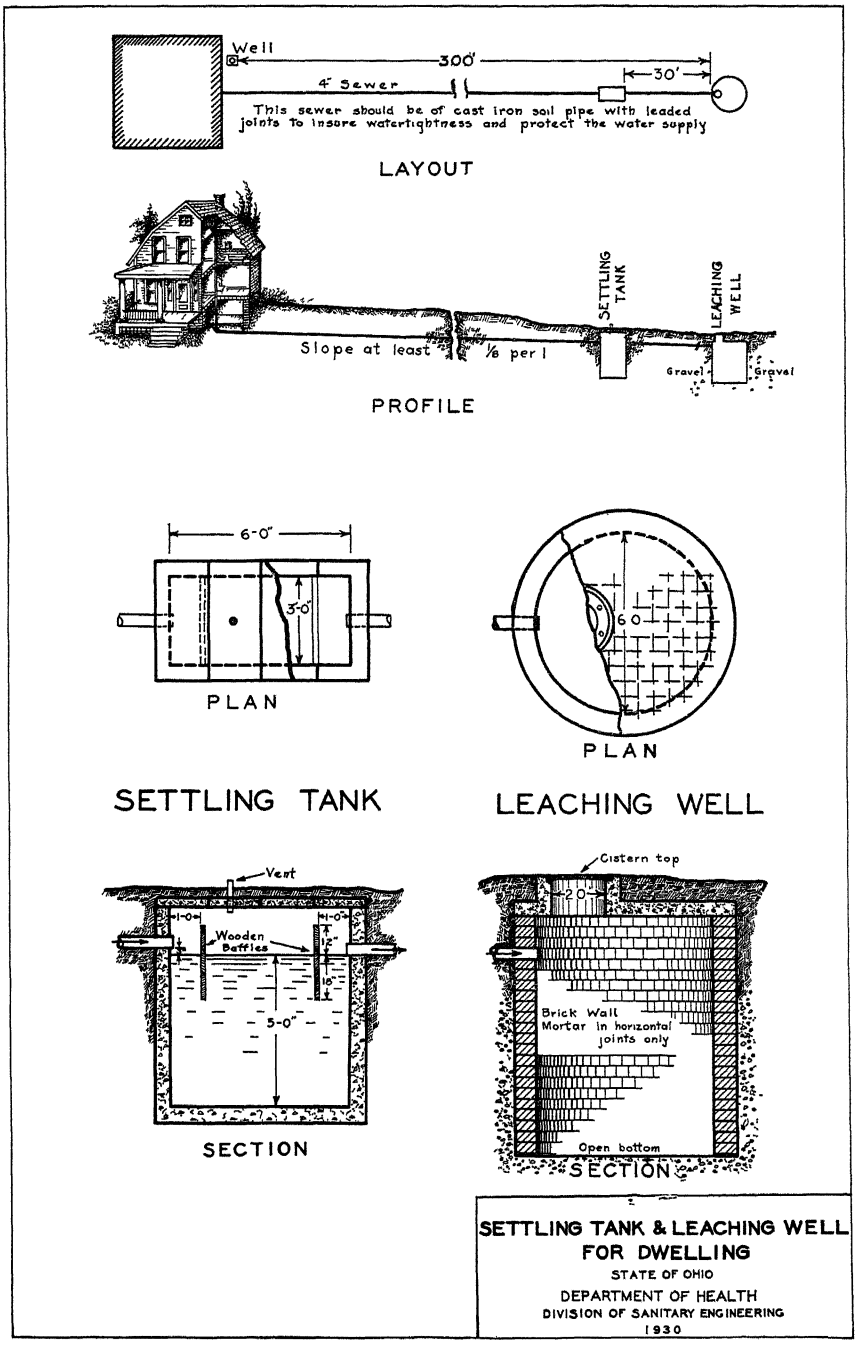


FIG. 2.—SETTLING TANK AND LEACHING WELL FOR DWELLING.

ture. Likewise, the outlet should draw from a depth of at least 24 inches below the surface. A removable concrete cover is provided to permit access to the tank for cleaning. The tank should not be airtight, but should be ventilated by a small vent such as that shown in Figure 2. The sludge must be cleaned from the tank occasionally, probably about once each year. The sludge may be bailed or pumped into barrels and conveyed to a distant place for burial.

The leaching cesspool must be of open construction, to permit the overflow of the settling tank to seep into the subsoil. To assure satisfactory operation the sides and bottom of the device must be in sand or gravel above the ground water level. The size of the leaching well depends on the character of the substrata. Generally speaking, the capacity of that portion of the well which is in sand or gravel should have a capacity equal to that of the settling tank, or at least 90 cubic feet. Hence, if the well is made 6 feet in diameter and sand or gravel is encountered 2 feet below the inlet sewer, the well should have a depth of 5 feet 8 inches below this sewer. The wall of the leaching well should be of soft brick or hollow tile laid with mortar in the horizontal joints only, and the bottom should be left open to the subsoil.

The success of a leaching well will depend on the operation of the settling tank. If the tank is not constructed properly and cleaned regularly, the solid matter will overflow to the leaching well and fill the pores of the subsoil.

Settling Tank and Subsurface Filter (Fig. 3)

The sanitary sewer and settling tank shown in this illustration are the same as those shown in Figure 2, and described on pages 6 to 8.

The subsurface filter is used where it is necessary, due to poor soil conditions, to discharge the effluent to a small water course or storm drain. As previously stated, in certain instances where the residence is located adjacent to a stream which contains a large flow of water throughout the year, it may be feasible to omit the filter and discharge the overflow from the settling tank directly into the stream. This method of sewage disposal, however, should not be adopted until the local health officials are consulted.

The subsurface filter should be located at least 300 feet from all water supplies, and the drainage course into which the effluent is discharged should also be removed at least this distance from any water supply. The filter can be constructed adjacent to the outlet end of the settling tank or at any point beyond the settling tank.

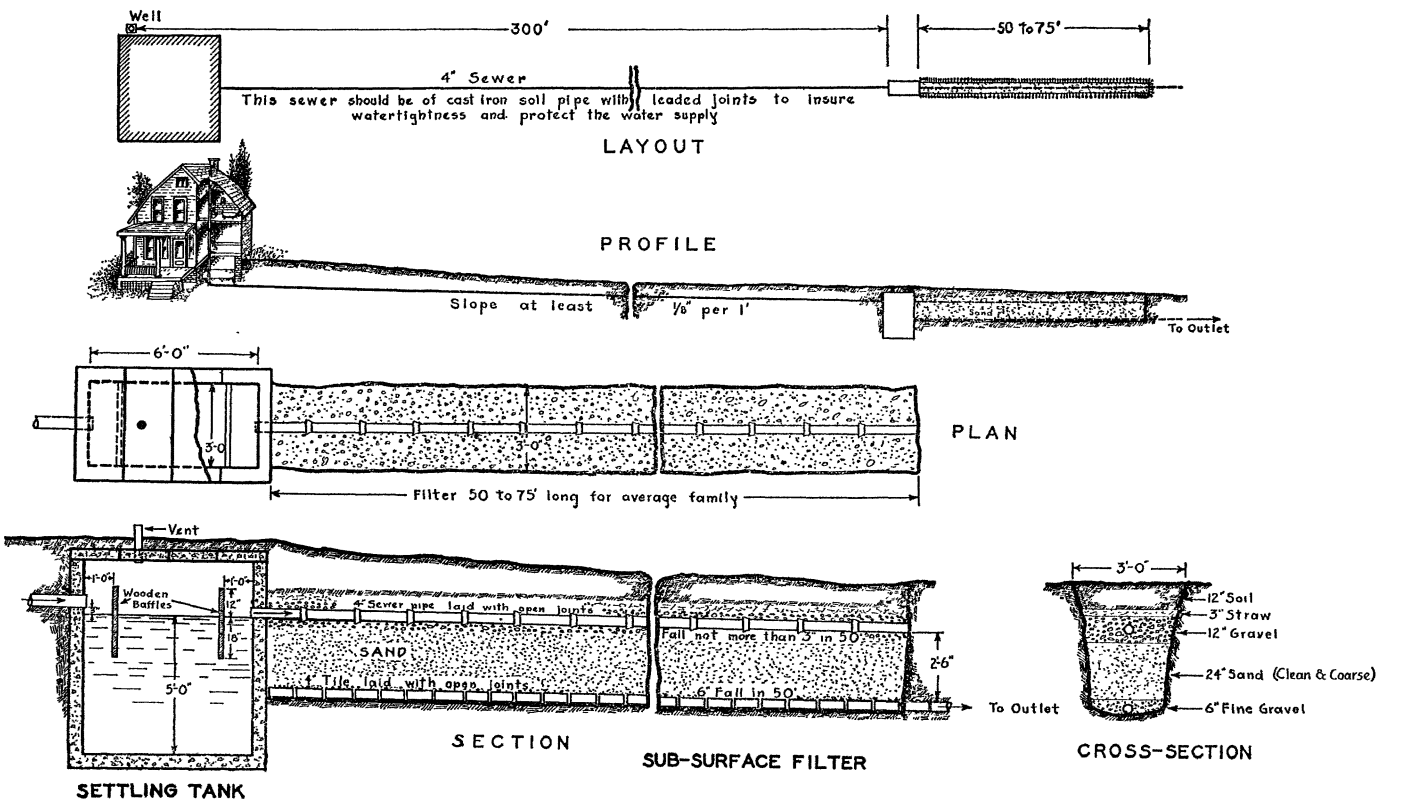


FIG. 3.—SETTLING TANK AND SUBSURFACE FILTER FOR DWELLING.

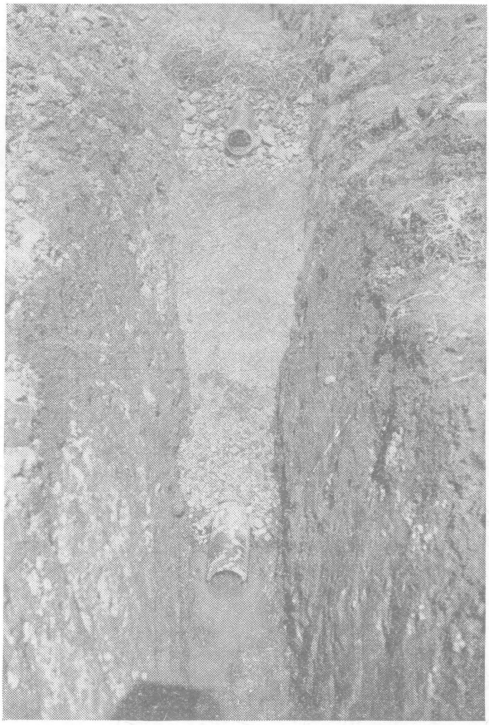


Fig. 4.—Section of the sub-surface filter. The 4-inch drain tile in the bottom of the trench are laid with about ¼ inch space between joints to permit easy entrance of filtered effluent.

Figure 3 shows a subsurface filter that may be made by digging a ditch at least 3 feet in width and 50 to 75 feet in length, depending on the number of occupants of the dwelling, and filling it with it at least 3½ feet of filtering material. The sewage is distributed over this filter bed by a line of 4-inch vitrified tile laid with open joints, and in a straight line from the settling tank outlet through the central part of the trench. Vitrified sewer tile are preferable to field tile, as settling of the bed will not throw sewer tile out of alignment nearly so readily.

The bed is drained by a line of 4-inch field tile laid on the bottom of the trench directly under the line of distribution tile. The cross section of the trench shown in Figure 3 shows the filtering material that should be used. Attention is particularly called to the fact that the sand must be clean, free from loam and dust, and of a fairly coarse uniform size. A layer of straw above the upper tile will prevent the top soil from working into the filtering material. Construction of trench is shown in Figure 4.

A natural subsurface filter may be used where the strata immediately underlying the top soil consists of sand or sand and gravel to a depth of 3 to 4 feet. The underdrains may be omitted if the ground is porous and is well drained, but the distribution tile should be increased to 6 or 8 inches in size.

As with a leaching well, the success and life of a subsurface filter depends on the operation of the settling tank. If the sewage is not properly clarified in the settling tank, the drains and filtering

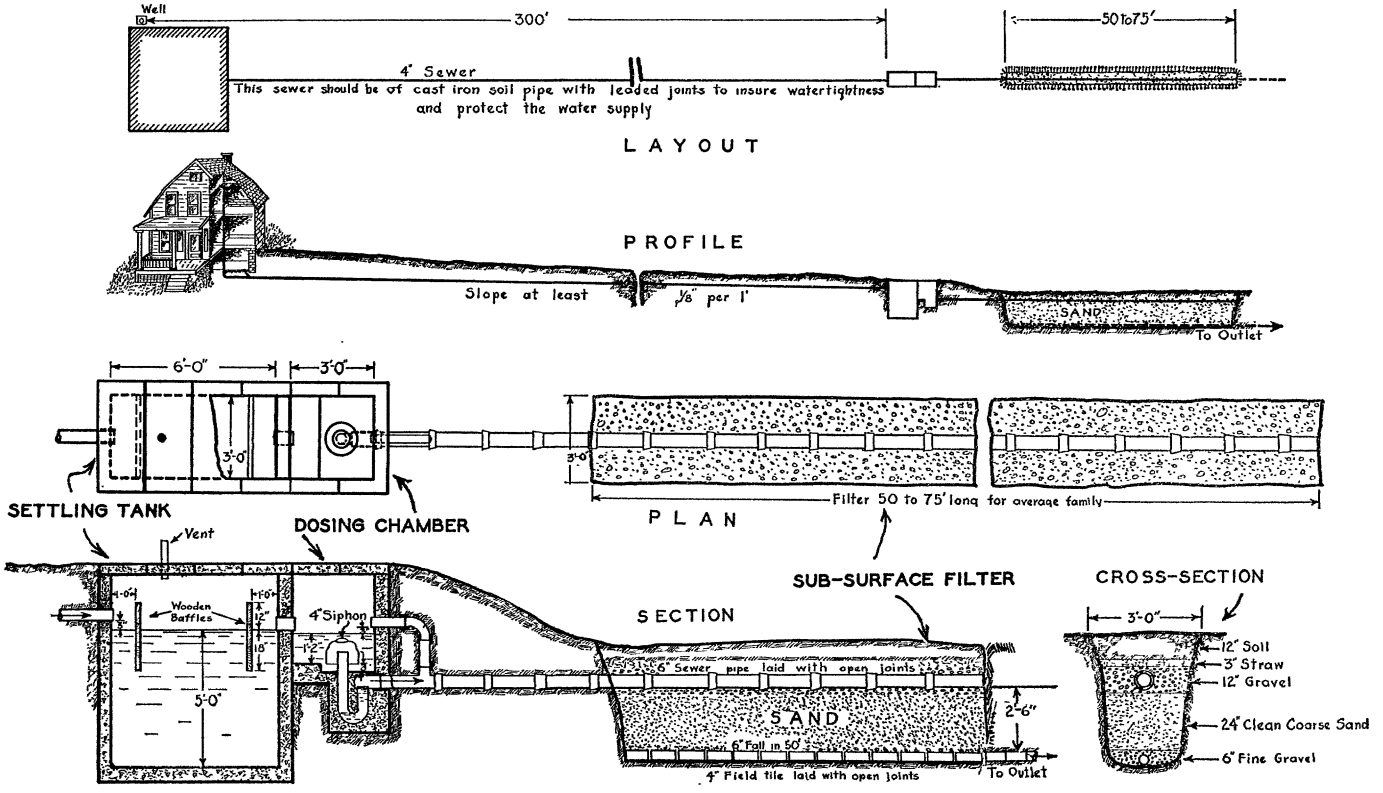


FIG. 5.—SETTLING TANK, DOSING CHAMBER, AND SUBSURFACE FILTER FOR DWELLING.

material will become clogged and the filter will be thrown out of service in a short time.

Settling Tank, Dosing Chamber and Subsurface Filter (Fig. 5)

A dosing chamber constructed adjacent to the outlet end of the settling tank, and equipped with a siphon which will automatically discharge the entire contents of the chamber into the distribution system of the filter, will increase the life and efficiency of the filter considerably. A design of this type is shown in Figure 5 and should be installed in preference to the system shown in Figure 3 if sufficient elevation is available. (See Figure 8 for details of form for dosing chamber.)

The settling tank and subsurface filter are similar to those shown in Figure 3. The dosing chamber has a capacity of about 78 gallons, which will be discharged into the distribution system by a special 4-inch siphon.

The distribution tile should be of 6-inch sewer tile at least 50 feet in length, to receive the total flow from the dosing chamber. The joints of these tile should not be crowded too close together. This allows the effluent to escape easily into the filtering material below. Do not concrete the joints of these distribution tile. The filtering material is similar to that specified in Figure 3.

Suggested Details of Construction

The economical construction of an efficient sewage disposal system depends upon careful attention to all details. The suggestions for construction which follow are the result of successful practice. Experienced workmen may have other methods of building forms and holding them in place. If the forms are not to be used over again a simple box, well braced, will be all that is needed. The plans shown, however, have special corner construction, which makes removal easy.

Carelessness in digging the hole true to dimensions may require 50 per cent more concrete than necessary, or may result in uneven thickness of walls. Improper grade is a frequent cause of sewer failure or of a clogged filter bed.

It is difficult in many localities to secure clean, well-graded sand and gravel for making concrete and for use in the filter beds. Good, water-tight concrete cannot be made from poor aggregates and, if the filtering material is not clean, the filter will soon become logged and cease to function properly.

PLANS FOR CONSTRUCTING REMOVABLE FORMS

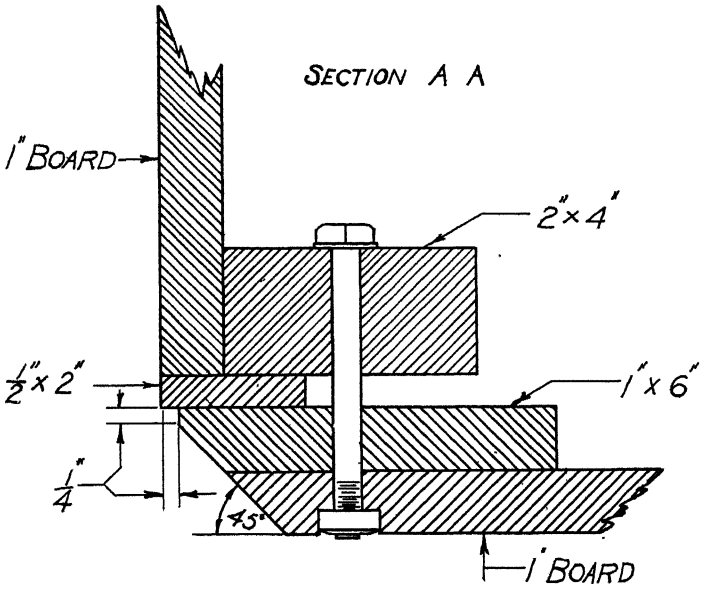


Fig. 6.—The above detail shows the construction of a corner of the forms. This type of corner makes it possible to remove the forms without damaging them.

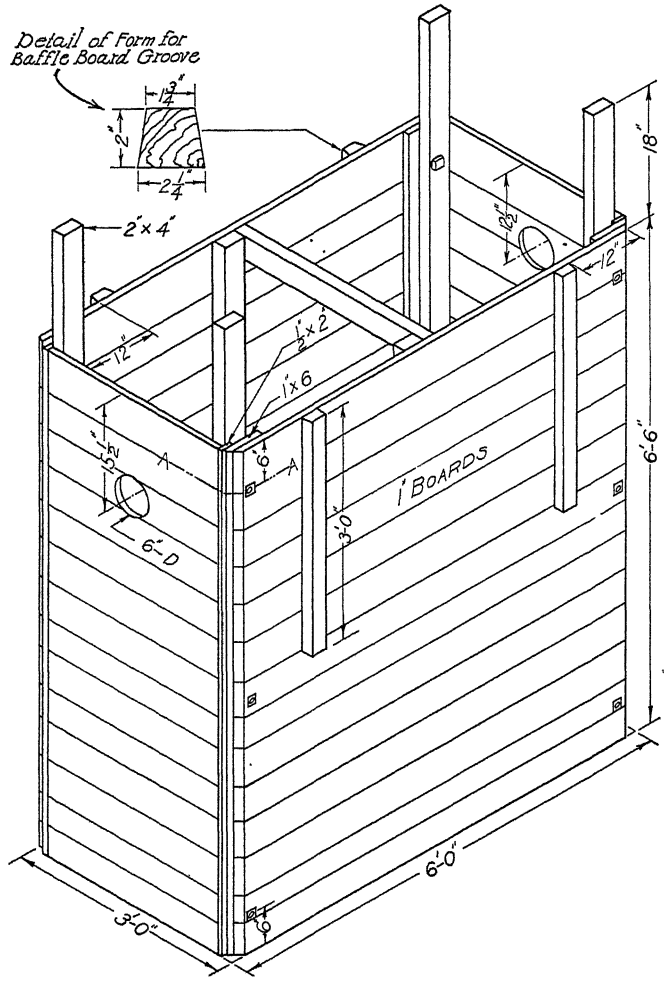


Fig. 7.—This sketch shows details of the forms. Note the special corner construction of these forms, which makes them easily removed. If the forms are to be used more than once, easy removal is essential. It is almost impossible to remove the ordinary box type of forms without breaking them up.

A detail of the corner is shown in Fig. 6, on page 13.

The holes in the forms for the inlet and outlet sewers should be one-half inch larger in diameter than the outside diameter of the sewer pipe to permit easy removal of the forms. (Also see Figs. 16 and 17 for this detail.)

The shape and dimensions of form for baffle board grooves are given in detail in upper left corner.

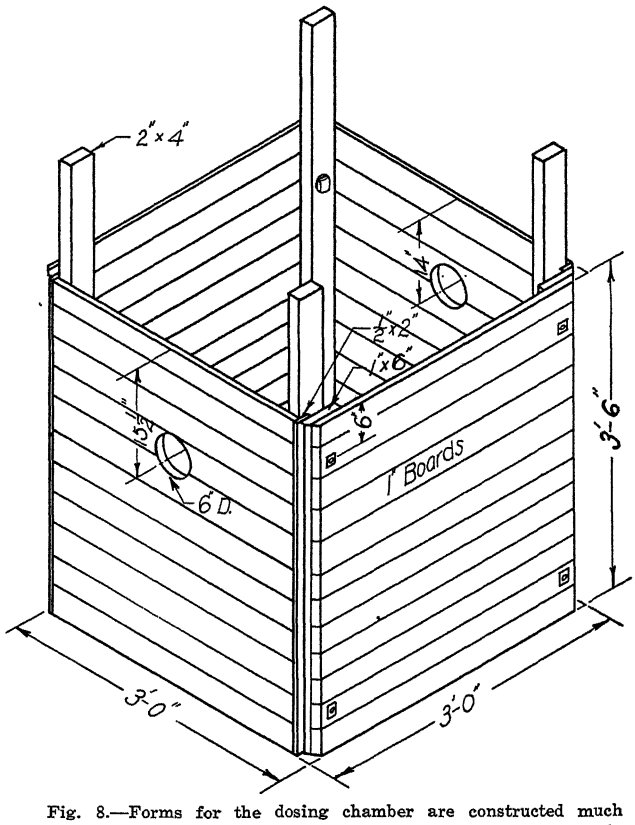


Fig. 8.—Forms for the dosing chamber are constructed much like those for the settling tank. They are held in place in exactly the same manner. A detail of the corner is shown in Fig. 6.

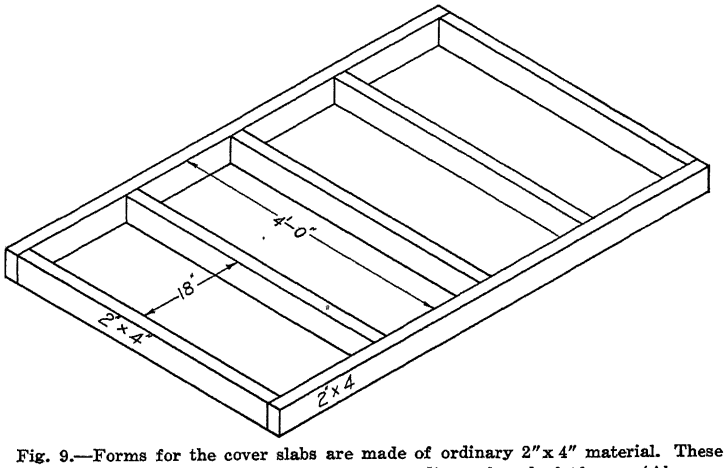


Fig. 9.—Forms for the cover slabs are made of ordinary 2"x 4" material. These forms may be laid on a barn floor or on an ordinary board platform. (Also see Figs. 18 and 19.)

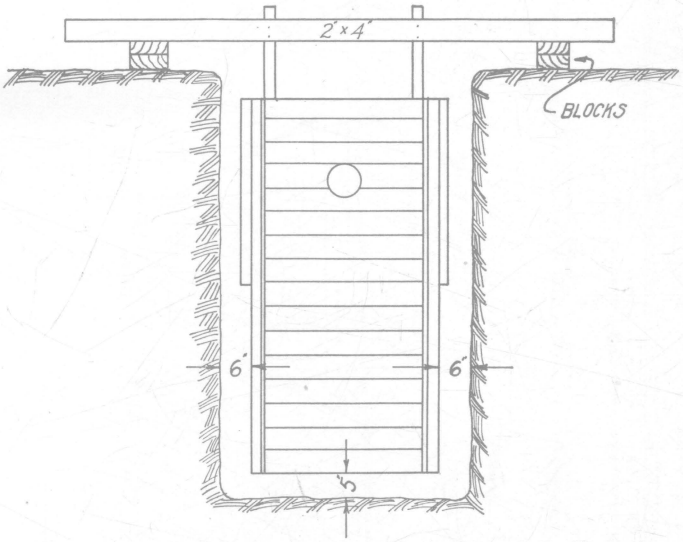


Fig. 10.—The forms may be supported as shown in the above illustration. Such support makes it easy to level the forms and hold firmly in place.

Fig. 11.—Assembling the forms. The entire outer surface of the forms is coated with old crankcase oil or cup grease. The workman is greasing one of the corner strips. This makes forms easy to remove.

THE EXCAVATION

A settling tank of the size shown in these plans will require an excavation 4 feet wide by 7 feet long by 5 feet 5 inches deep below the bottom of the outlet sewer. Frequent use of a carpenter's level as the digging proceeds will insure accurate dimensions and plumb sides.

A careless job of excavating will result in unequal thickness of walls. The use of two gauge sticks, one 4 and the other 7 feet long, will aid in checking on

the width and length of the hole.

THE FORMS

No outer forms are necessary unless the soil caves badly.

If the forms are not to be used over again for building other tanks, a simple rectangular box 3' feet wide, 6 feet long, and 6 feet 6 inches deep may be used. If, however, the forms are to be used again, special corner construction is necessary. Figure 6 shows the details of a corner which permits the easy removal of forms.

Fig. 12.—Assembling the forms. One of the corner strips is being placed in position before bolting together. The use of these greased strips makes the removal of the forms easy. (See Fig. 6 for details of form.)

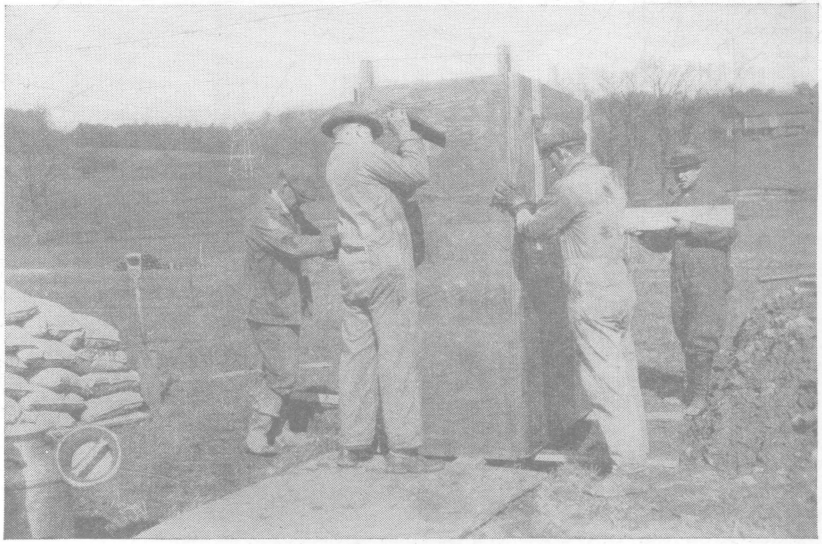


Fig. 13.—The forms in position for lowering into place. A board has been temporarily nailed across one end as a handle to aid in moving the forms and lowering them part way into the hole

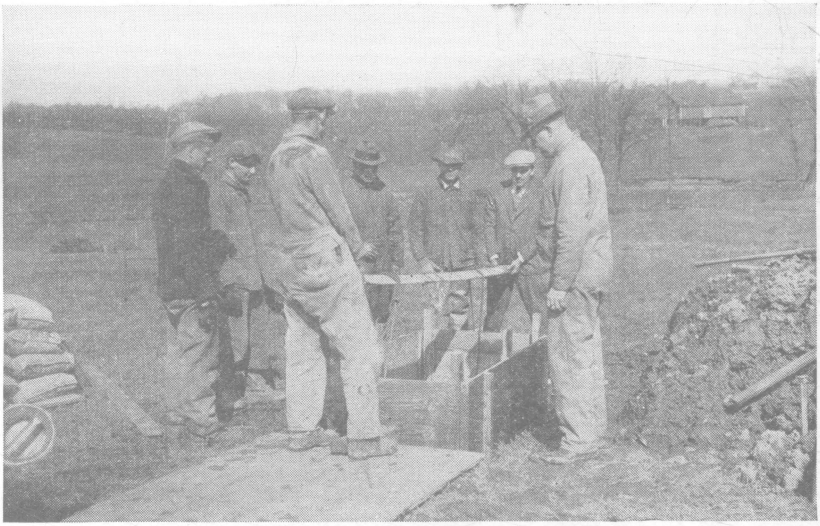


Fig. 14.—Lowering the forms into place. After lowering part way down the forms are suspended by ropes and lowered on down into place.

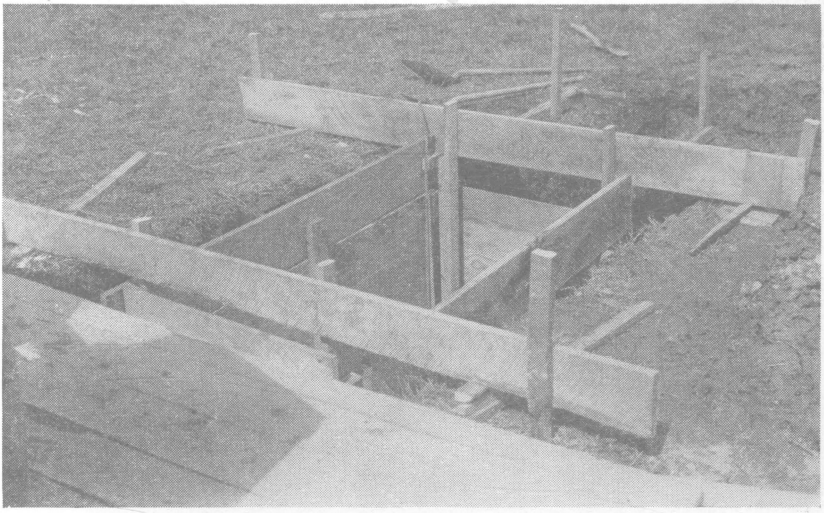


Fig. 15.—The forms are supported and held in place from the surface of the ground as shown in the above illustration. The bottoms of the forms are 5 inches above the bottom of the hole. It is easy to level the forms by blocking up as shown.

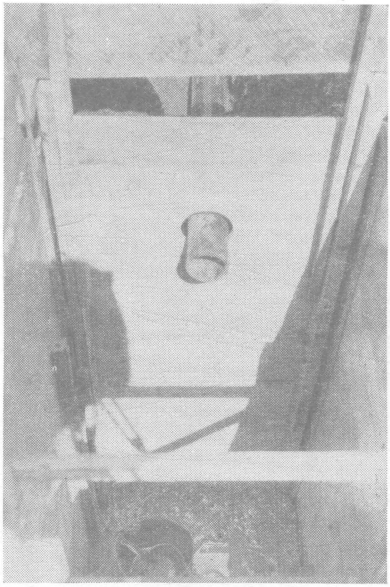


Fig. 16.—Looking into the tank just before pouring the concrete. If there is any water in the hole it should be bailed out before any concrete is poured.

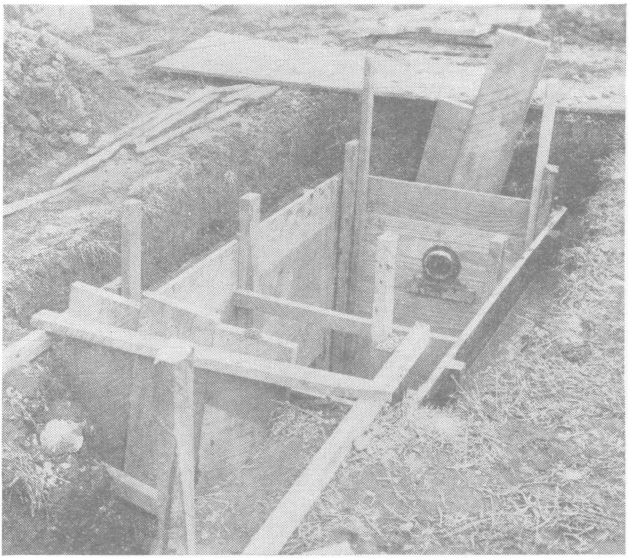


Fig. 17.—This picture shows the settling tank just after the concrete was poured. The trench at each end of the tank has been closed with boards set in a vertical position.

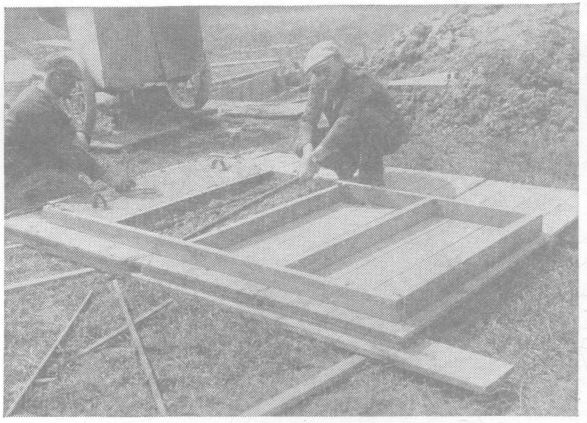


Fig. 18.—The forms for the cover slabs can be assembled on a board platform or on a barn floor. Two reinforcing rods are placed about one inch from the bottom of each slab.

The holes for inlet and outlet sewers should be ½ inch larger than the outside diameter of the sewer pipe, to permit easy removal of forms. These holes may be omitted and the sewer pipe butted against the forms. Details of the forms are shown in Figs. 6 to 10.

The forms may be lowered into place as shown in Figure 14. A method of supporting the forms from the surface of the ground is shown in Figure 15. This makes it easy to level the forms and center them in the hole. The supporting cross pieces rest on blocks and are held in place by stakes as shown in illustration.

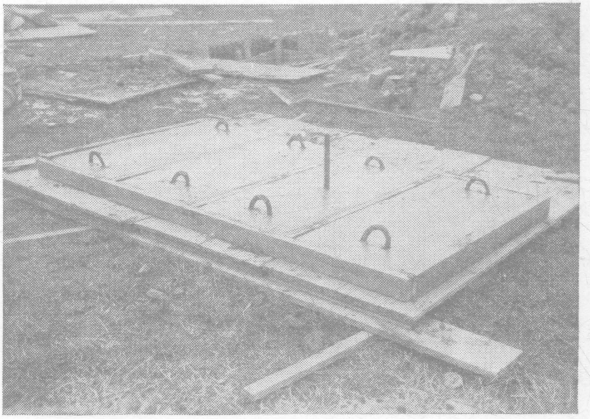


Fig. 19.—The finished cover slabs. Two old horseshoes in each slab form convenient handles for moving the slabs into place. The vent pipe in one slab extends above the surface of the ground after the slabs are in place.

Mixing and Placing Concrete

The recommended concrete mixture for settling tank construction is one containing 4¼ gallons of water per sack of cement, when moist sand and pebbles are used. With dry aggregates use 5½ gallons of water per sack of cement, and if the aggregates are dripping wet the amount of water to be added at mixing is 3¾ gallons. Aggregates may be up to 1 inch in size and are used in the

ratio of about 2 parts sand to 3 parts pebbles for each part of cement.

Definite quantities of aggregates are determined by trial. For the first batch combine 1 sack of cement, 2 cubic feet of sand, and 3 cubic feet of pebbles or broken stone (1-2-3 trial mix), using quantities of mixing water specified above. If too stiff a mix results use less sand and pebbles in succeeding batches. If the mixture is too wet add more sand and pebbles. Do not vary the quantity of mixing water from the amounts given above. The concrete should be of such consistency that it can be deposited and placed readily yet requires some tamping to get it to settle properly into the forms. Sloppy mixes should be avoided.

Concrete may be mixed by machine or by hand. In either case mixing should continue until every pebble or stone is completely coated with a mortar of sand and cement. Concrete should be deposited in the forms within 45 minutes after mixing, in uniform layers, 6 to 10 inches deep, and carefully spaded to settle it into all angles and corners of the forms.

The sides of the tank may be poured before the floor. This prevents heaving of the bottom next to the forms, as frequently happens when the bottom is poured first. Some experienced concrete men prefer, however, to pour the bottom first and then support the forms upon the freshly poured floor.

For the cover slab use the same concrete mixture that is recommended for floors and walls.

MATERIAL FOR SETTLING TANK WITHOUT DOSING CHAMBER

3 cubic yards coarse gravel or crushed stone
2 cubic yards sand
26 bags portland cement
8 reinforcing bars, ½″×3′-10″
6 baffle planks, 2″×10″×3′-3″

MATERIAL FOR SETTLING TANK WITH DOSING CHAMBER

3.75 cubic yards coarse gravel or crushed stone
2.5 cubic yards sand
32 bags portland cement
12 reinforcing bars, ½″×3′-10″
6 baffle planks 2″×10″×3′-3″
1 4-inch automatic siphon

Material for Removable Forms for Settling Tank

135 board feet, ⅞" boards, 12 feet long, any width
6 pieces 2"×4"×8'-0" frame pieces
4 pieces 2"×2"×3'-0" bevel groove strips
4 pieces ⅜"×1½"×6'-6" corner strips
5 pieces 2"×4"×4'-0" cover slabs
2 pieces 2"×4"×7'-8" cover slabs
4 pieces 1"×6"×6'-6" side frame
3 pieces 1"×6"×3'-0" cross braces
12 machine bolts with washers, ⅜"×4"
3 pounds 8-penny nails
1 pound 6-penny nails

Material for Forms for Dosing Chamber

48 board feet, ⅞" boards,, 12 ft. long, any width
4 pieces 2"×4"×5'-0" frame pieces
4 pieces ⅜"×1½"×3'-6" corner strips
4 pieces 1"×6"×3'-6" side frame
8 machine bolts with washers, ⅜"×4"
1½ pounds 8-penny nails

Material Required for 50 Feet of Length of Sub-Surface Filter

2 cubic yards fine gravel—bottom of trench
8 cubic yards clean coarse sand
5½ cubic yards coarse gravel
1 bale of straw
50 feet 4" drain tile
50 feet 4" sewer tile

PRIVY VAULTS

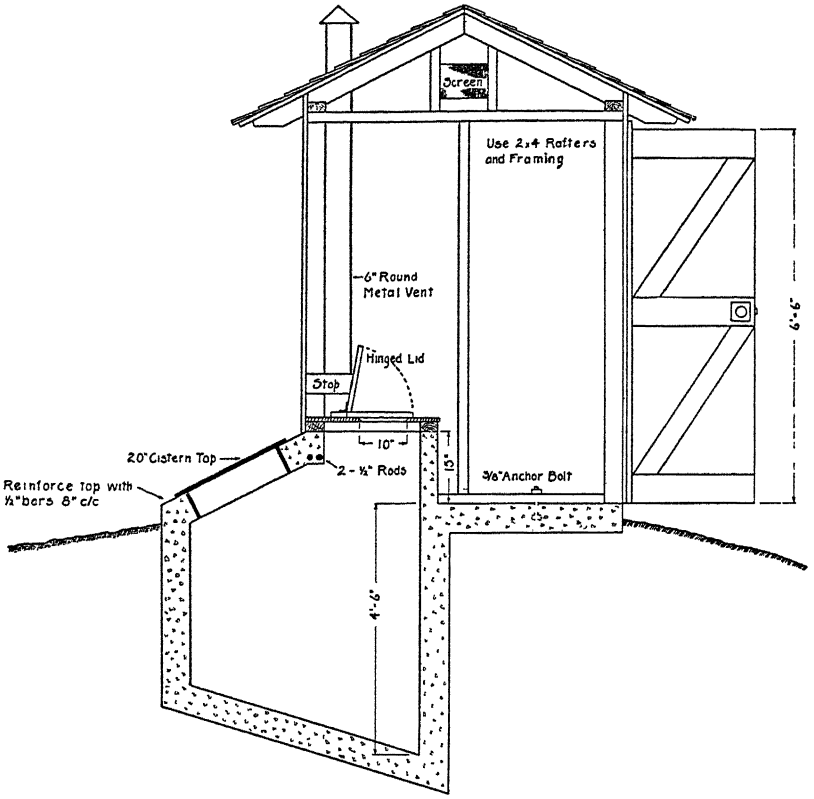
The principal features to be embodied in the design of a privy for the home are watertightness, ventilation, and facilities for cleaning. The vault must be watertight to avoid contaminating water supplies, and must be fly tight to prevent access of flies to the contents of the vault. This latter precaution is essential to prevent flies from carrying contamination to foodstuffs. The State Building Code of Ohio requires that privy vaults shall be constructed watertight and shall not be located within 20 feet of any building of human habitation or occupancy, or within 50 feet of any cistern, well, spring or other source of water supply used for drinking or culinary purposes, whether they be located on the same or adjoining properties.

PRIVY WITH TIGHT VAULT (FIG. 20)

(See page 24)

This diagram illustrates a privy with a watertight concrete vault that may be cleaned through a 20-inch manhole located to the rear of the superstructure, and is ventilated by a 6-inch vent pipe extending through the roof of the building. Precautions must be taken to make the vault watertight. The concrete should be well tamped and should be coated on the inside with waterproofing or neat cement mortar. Self closing covers for the seats are shown, and the manhole cover fits tightly to prevent the entrance of flies or vermin into the vault. The vault should be cleaned regularly and small quantities of lime should be used frequently to prevent the dissemination of odors.

The privy vault illustrated conforms in all respects to the various sections of the State Building Code relating to privy construction. For details of these sections reference is made to Sections 12600-265 to 272 inclusive, General Code of Ohio.



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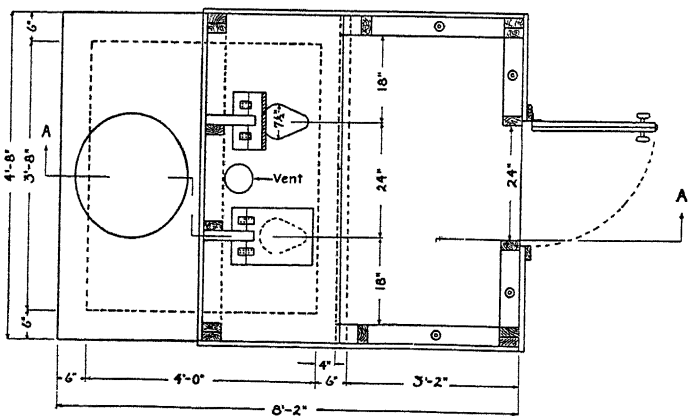

PLAN

FIG. 20.—DETAILS OF CONSTRUCTION OF PRIVY VAULT (See page 23).

There are many special problems of farm sewage disposal not discussed in this bulletin. No sewage disposal system should be installed in thickly settled communities without first consulting the local health officials.

For information on problems of sewage disposal not clearly covered by this bulletin, write to the Ohio Department of Health, Columbus, Ohio.